

Determinants of Gender Division in Agricultural Works and Agrobiodiversity Management in Nepal

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Abstract

This study was designed to assess the access of Nepalese farmers to the training and extension service, gender division on agricultural work, and factors affecting agrobiodiversity management activities. A total of 2,817 respondents were interviewed at different locations throughout Nepal. The information was collected using the mWater surveyor. Descriptive and inferential analyses were done. The respondents having received training in agriculture were significantly higher among elite, educated, and agricultural households. Access to extension facilities was significantly determined by the type of household, ethnicity, occupation, and education of respondents. Male domination in the choice of crops, land preparation, and seed selection were significantly higher in male-headed households, marginalized groups, and agricultural households. However, females were more likely to be involved in seed sowing. The male domination in male-headed households were significantly higher for applying fertilizers, weeding, irrigation, and pest control. Among elite ethnic groups, domination of males was significantly higher for fertilizer application. The role of the male in agricultural households was significantly higher in all aspects. One unit increase in the area increased the likelihood of male involvement in irrigation by 30%. The males are likely to be more involved in harvesting, sales of products, and control of income. Elite and educated respondents coupled with access to training practiced more crop rotation compared to the rest. The likelihood of practicing intercropping and mixed cropping was influenced by extension facilities and training facilities. Elite groups and farmers with extension facilities tended to practice more agroforestry. So, the types of households, education, and ethnicity have a key role in the gender differentiation in agriculture operation. Moreover, training and extension facilities help a lot in the conservation and practice of agrobiodiversity. There is an urgent need in improving the women's role and overall management of the agricultural landscape.

Keywords

Gender; Domination; Agrobiodiversity; Improvement

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1. Introduction

Nepal occupies only 0.03% of the world's total area and yet harbors over 3.2% of the world's known flora and 1.1% of the world's known fauna (GoN/MoFSc, 2014). With 118 types of ecosystems and classification of 75 types of vegetation, 35 types of forest and 5 types of rangelands make Nepal a part of the world's biodiversity hotspot (CBD, undated). A total of 24,300 species are reported of which 28% (6,618 species) are agricultural species. The species richness of agricultural flora (2,833 species) is found higher than agricultural fauna (3,785 species) (Joshi *et al.*, 2020). Over 550 crop species have been identified to have food values and about half of those species are being cultivated in various regions of the country. Over 200 different species of vegetables are grown and consumed in the country (Shrestha, 2013). Despite the wide range of diversity, with rapid change in food habits of people the dependency of people in cereals especially rice, maize, and wheat increasing tremendously which covers 83% of the total cultivated land of the country (Hussain, n.d.; Joshi *et al.*, 2019).

Agricultural biological diversity is considered a subset of biodiversity (FAO, 1999). This diversity is a result of continuous selection by nature along with careful human selection and intervention. Agricultural diversity is not only closely linked with the livelihoods and economic wellbeing of the majority of people but also promotes food and nutritional security. Indigenous knowledge of local people, ethnic and cultural diversities is an integral part of agrobiodiversity management. The dynamic and complex livelihood of people highly depends upon the plant and animal diversity in both wild and domesticated forms (FAO, 2005). Biodiversity conservation and management involve the sustainable use of biological resources, which is often gendered. In most farming systems, there is a division of labor among males and females that determines their roles and responsibilities in farming. Generally, men are absent in most of the production process as they have migrated to foreign countries to earn alternative income leading to the active participation of women in household activities and an increase in the workload of women (Giri and Darnhofer, 2010; Tobin and Aguilar, 2007; Slavchevska *et al.*, 2020).

The preferences of men and women including the utilization of biological resources and conservation practices are not always the same. As women are more actively involved than men in household activities, they have more knowledge about the patterns and use of local biodiversity. They play important role in the selection, improvement, adaptation, and management of a very diverse range of varieties, whereas men prefer using these resources to earn income. Despite their contribution, women are denied equal access to, and control over, natural resources, including agrobiodiversity management (Bhattarai *et al.*, 2015). This signifies that women's and men's roles and knowledge of biodiversity conservation and management are not static (Khadka and Verma, 2016). Agrobiodiversity management is not just affected by climate change and gender relations but is also driven by socio-economic factors of the society like the increased rate of out-migration of men resulting in the shortage of farm labor and an increase in remittances allowing their families to use store-bought food from the market resulting into the abandonment of traditional crops (Arora-Jonsson, 2011; UN Women, 2017). It should be widely accepted that failure to include women in decision-making processes regarding climate change mitigation and adaptation strategies not just intensifies the problems of gender inequalities but also challenges the effectiveness of management and conservation practices. This deprives us of achieving more equitable and appropriate climate change policies and programs that favor proper agrobiodiversity management practices (Esplen, 2008).

Thus, this study was conducted to find out the role of gender and other socioeconomic variables in affecting the gender division of agricultural work. Also, this study intends to find out the factors affecting the choice of agrobiodiversity management activities with increasing cases of climate change.

2. Methodology

This study was conducted at various places in Nepal as shown in figure 1. Around 150 students at the Institute of Agriculture and Animal Science (IAAS) were employed as investigators and each student was responsible for surveying 30 household in their locality. The selection of households was done using a simple random sampling technique. The household survey was done by developing a questionnaire using the mWater portal (<https://portal.mwater.co>) and data collection was done through the mWater surveyor using smartphones. The survey was conducted by carrying out about 30 minutes of personal interviews with the informants. For the accuracy of the information collected, the interview sites were at least 20 meters away from each other. A total of 2,817 responses were obtained across the various locations of Nepal. The sampling of respondents was done by convenient sampling method as respondents were directly or indirectly involved in agriculture. Verbal consent was obtained from all respondents before asking the questions. The confidentiality of information was maintained. Personal identifiers were not collected, and any identifying information taken accidentally was removed from the text during the processing of data. The data processing was done in MS EXCEL that was then imported to Statistical Package for Social Science (SPSS version 20) where analysis was performed. During the analysis, both descriptive and inferential analysis were done as and when required. Descriptive analysis included frequency, percentage, and mean value. Additionally, during inferential analysis, Chi-square test and binary logistic regression were done. The data were interpreted and summarized into the tabulation form.

3. Result and Discussion

3.1 Basic Information of the Respondents

Among the household respondents, 53.1% were females and 46.9% were males. 84.3% of the households were male-headed and only 15.7% were female-headed households. 20.3% of total households were illiterate, 21.6% could read and write, 20.5% received primary education, 23.6% received secondary education and 14% received higher-level education. 54.8% were from elite groups¹, 34.9% were marginalized and touchable² and 10.3% were of marginalized and untouchable groups³. The greater numbers of respondents were found to have agriculture (67.1%) as a primary source of occupation, followed by service (13.8%), remittance (9.8%), business (7.4%), and others (1.9%). The average family size was 5.37. The average economically dependent family members were 2.99. The landholding and area of cultivated land on average were 0.56 ha and 0.43 ha, respectively (Table 1).

¹ Elite group is upper caste group namely Hill Brahmin and Hill Chhetri.

² Marginalized and touchable group is deprived of facilities enjoyed by elites. It includes ethnic groups (*Adibasi Janajati*), *Madhesi*

³ Marginalized and untouchable group includes low caste people who are often regarded as untouchables and are deprived of basic rights and social inclusion.



Figure 1: Sites of data collection

Table 1: Socio-demographic information of respondents

<i>Gender</i>	
Male	1319(46.9)
Female	1492(53.1)
<i>Type of household</i>	
Male headed	2372(84.3)
Female-headed	442(15.7)
<i>Education status of household head</i>	
Illiterate	571(20.3)
Read and write	607(21.6)
Primary	575(20.5)
Secondary	663(23.6)
Higher	393(14)
<i>Ethnic Groups</i>	
Elite (Bhramins and Chhetris)	1541(54.8)
Marginalized and touchable	983(34.9)
Marginalized and untouchable	290(10.3)
<i>Primary source of occupation</i>	
Agriculture	1890(67.1)
Remittance	276(9.8)
Business	208(7.4)
Service	388(13.8)
Others	53(1.9)
<i>Average family size</i>	5.37

<i>Average economically dependent family members</i>	2.99
<i>Average area in hectare</i>	0.56
<i>Average area of cultivated land in hectare</i>	0.43

Note: Figure in the parenthesis includes percentage

3.2 Engagement and Type of Farming

Engagement in farming was significantly affected by types of households ($X^2=5.61$, $P<0.05$), ethnicity ($X^2=12.44$, $P<0.01$), and education ($X^2=26.24$, $P<0.001$). Whereas the engagement in farming was insignificant with respect to the type of farming, however, it was significantly different in ethnicity ($X^2=62.78$, $P<0.001$) and education level of respondents ($X^2=19.14$, $P<0.05$). Details about each group are given in table 2.

National statistics collected in 2014 by CBS show that the average area of land owned by women is almost half (0.4 hectares) than that of men (0.7 hectares) (Central Bureau of Statistics, 2014). Female-headed households reported for 19.7 percent of the total agriculture landholders in 2011, an increase from 10.8 percent in 2001 (Sahavagi, 2015). However, due to the out-migration of male-head of the family for employment opportunities, the number of female-headed households is increasing in recent times. This condition has generated both challenges and opportunities for women regarding the management of farms (Slavchevska *et al.*, 2020). As male out-migration has increased, the workload on women is leading some of the women giving up farming (Slavchevska *et al.*, 2020). In most cases, there is an increased women's participation in agricultural production, market access and improving their leadership skills, leading to increment in household income, food security, and independence (UN Women, 2017).

Table 2: Farmers engaged in farming and type of farming followed with respect to gender, ethnicity, and education

	<i>Engagement in farming (yes)</i>	<i>Subsistence</i>	<i>Type of farming</i>	
			<i>Semi- commercial</i>	<i>Commercial</i>
<i>Types of households</i>				
Male headed	2199(92.8)	1565(72.6)	483(22.4)	107(5.0)
Female-headed	394(89.5)	299(77.5)	67(17.4)	20(5.2)
Chi square	5.61*	4.94ns		
<i>Ethnicity</i>				
Elite	1414(92)	947(68.3)	363(26.2)	76(5.5)
Marginalized and touchable	924(94.1)	689(76.1)	168(18.6)	48(5.3)
Marginalized and untouchable	255(87.9)	227(90.8)	20(8.0)	3(1.3)
Chi square	12.44**	62.78***		
<i>Education</i>				
Illiterate	422(90.4)	321(78.1)	74(18.0)	16(3.9)
Read/write	534(94.8)	413(78.4)	90(17.1)	24(4.6)
Primary	496(94.1)	335(69.4)	121(25.1)	27(5.6)
Secondary	515(94.3)	357(71.4)	116(23.2)	27(5.4)
Higher	627(88.7)	439(70.7)	149(24.0)	33(5.3)
Chi-square	26.24***	19.14*		

Note: Figure in the parenthesis includes percentage, *** = $P<0.001$, ** = $P<0.01$, * = $P<0.05$ and ns = not significant

The majority of marginalized and untouchable households (90.8%) were engaged in subsistence types of farming followed by semi-commercial (8%). The least percentage (1.8%) of this group of households was found to be involved in commercial farming (Table 2). This value indicates that the majority of the respondents were involved in subsistence agriculture which is in line with the report published by FAO (2019). Households involved in commercial farming were mostly elites followed by marginalized and touchable. This condition is found due to larger landholdings of these groups and accessibility of inputs. These groups are resource rich as compared to marginalized groups of people (GoN, 2016). Due to these constraints, marginalized people are more involved in subsistence farming due to fewer landholdings and minimum capability to invest in inputs and resources. Also, due to the small and fragmented landholdings of rural people, the commercialization of agriculture is being difficult (Gharti and Hall, 2020).

As shown in table 2, 90.4% of illiterate, 94.8% with the ability to read and write, 94.1% with primary education, 94.3% with secondary education, and 88.7% with higher education were engaged in farming. The engagement of farming was significantly different with respect to the education status of the respondents. This relation was also found significant ($X^2=19.14$, $P<0.05$) with respect to types of farming. The majority of farmers of the study area were involved in subsistence farming. In the case of commercial farming, among the total respondents, the ones with primary level of education were more involved in commercial farming (5.6%), followed by secondary educated (5.4%), higher educated (5.3%), who could just read/write (4.6), and the least involved were the respondents who were illiterate (3.9%). Uneducated groups of people feel difficulty in understanding new technologies, production complexes and fail to understand their profitability (Bhatta and Doppler, 2010). They resist change and are comfortable with traditional subsistence farming practices (Ayandiji *et al.*, 2009). Also, this signifies the lack of interest in commercializing agriculture among highly educated people for their livelihood or their out-migration to cities for employment (Neupane and Poudel, 2021). People with primary education may be more open to possibilities, responsive to new technology, and thus may show more interest in commercial agriculture rather than getting involved in a full-time job.

Bhandari *et al.* (2015) found that most of the people in rural areas are illiterate and are involved in agricultural activities. Mostly the women who belonged to the ethnic groups (tribes) are found illiterate than the Brahmin/Chhetri (elite groups). The tribal community is one of the disadvantaged communities of Nepal who are generally found living in abject poverty (Patel, 2012). They generally have less access to resources and capital, and, hence, follow the old culture of subsistence farming.

3.3 Factors Affecting Access to Training and Extension Services

Access to training on agriculture was found to be dependent on ethnicity, primary occupation, and education of respondents. The access to training was 76% more likely in elite groups as compared to marginalized groups ($P<0.001$). Moreover, respondents with agriculture as a primary occupation are 44% more likely to have access to training ($P<0.001$). Similarly, the access to training was 2.89 times more for educated respondents ($P<0.001$). 7.7% variation in the dependent variable was explained by independent variables. The model was found to be significant ($X^2=151.45$, $P<0.001$). 74.3% of cases were correctly predicted (Table 3). This signifies elite groups have more access to agricultural training as they have more influence in society than marginalized ones (Dhital, 2017). Also, educated people keep updating themselves with new techniques and show more interest in the participation of training programs than the uneducated group of people (Ayandiji *et al.*, 2009) In recent years, due to the

prioritization of women and marginalized people in training programs, their participation is improving (UN Women, 2017).

Table 3: Odds ratio explaining the factors affecting the access of farmers to training on agriculture and access to agricultural extension facilities

	<i>Training on agriculture</i>	<i>Access to extension</i>
Type of household (male headed=1)	0.86ns	0.74*
Ethnicity (elite=1)	1.76***	1.73***
Occupation (Ag=1)	0.56***	0.57**
Education (educated =1)	2.89***	2.04***
Intercept	3.26***	3.63***
Model Chi-square	151.45***	119.89***
Nagelkerke R ²	0.077	0.061
% correctly predicted	74.3	73.2

Note: *** = P<0.001, ** = P<0.01, * = P<0.05, ns = not significant

Similarly, access to extension facilities was governed by the type of household, ethnicity, primary occupation, and education of respondents. The access to agricultural extension facilities for males as compared to females were 26% more likely in male-headed households to female-headed households. Also, marginalized groups are 73% less likely to access such facilities in comparison to elite groups. Respondents from agriculture as a primary occupation were 43% more likely (P<0.01) to have such access. The educated farmers having access to the extension were 2.04 times more likely as compared to non-educated. The model was found to be significant ($X^2=119.89$, P<0.001). 73.2% of cases were correctly predicted (Table 3). This signifies even though women have access to training facilities, but they are deprived of access to services as compared to males. Elite and educated groups being influencers in society can maintain better relations with the extension workers and other bureaucrats of the system (Dhital, 2017). Thus, providing them more access to extension services (Acharya, Shakya and Metsämuuronen, 2011). In many cases, due to lack of proper monitoring and inclusiveness, the marginalized group of people and women have less access to these facilities as compared to elites and males (Dhital, 2017). Subedi (2008) also reported that marginalized (both touchable and untouchable) have comparatively low access to knowledge and information as compared to Brahmin and Chhetri (elites).

3.4 Gender Differentiation of Agrobiodiversity Management Activities

The males dominating the choice of crops in the male-headed household was 9.53 times higher than female-headed households (P<0.001). Males were 36% more likely to influence the choice of crops in elite groups compared to marginalized groups (P<0.01). Similarly, for the same purpose, the domination of males in the family with agriculture as a primary occupation was 2.19 times higher than other occupational families (P<0.001). The relation was not significant with education and area of cultivation. The model was found to be significant ($X^2=479.03$, P<0.001). 23.7% variation in the dependent variable (choice of crops with respect to gender) was explained by independent variables. 80.2% of the results were correctly predicted (Table 4). In the male-headed household, the choice of crops was seen as dominant by males. A similar condition is seen in elite and agricultural dominant families. Even though most of the farming decisions are controlled by males, most of the household and farm activities are carried out by females (Bhattarai, Beilin and Ford, 2015).

Table 4: Gender differentiation of choice of crop, land preparation, seed selection, and seed sowing

	<i>Choice of crops</i>	<i>Land preparation</i>	<i>Seed selection</i>	<i>Seed sowing</i>
Type of household (male headed=1)	9.53***	7.28***	6.08***	-4.18***
Ethnicity (elite=1)	1.36**	1.06ns	1.39***	1.08ns
Occupation (Ag=1)	2.19***	2.12***	1.56***	1.59***
Education (educated =1)	1.19ns	1.11ns	1.18ns	1.37**
Area of cultivated land (ha)	1.11ns	1.05ns	1.02ns	1.10ns
Intercept	0.28***	1.05ns	0.27***	0.30***
Model Chi square	479.03***	278.96***	322.57***	221.82***
Nagelkerke R ²	0.237	0.178	0.150	0.103
% correctly predicted	80.2	88.3	72.0	66.4

Note: *** = P<0.001, ** = P<0.01, * = P<0.05, ns = not significant

The males dominating the land preparation in male-headed households was 7.28 times higher than female-headed households (P<0.001). Similarly, for the same purpose, the domination of males in the family with agriculture as a primary occupation was 2.12 times higher than other occupational families (P<0.001). The relation was not significant with ethnicity, education, and area of cultivation. The model was found to be significant ($X^2=278.96$, P<0.001). 17.8% variation in the dependent variable (land preparation with respect to gender) was explained by independent variables. The result was 88.3% predicted correctly (Table 4). Land preparation is considered as heavy-work; thus, the domination of males is higher than that of females in both male-headed and agricultural households (Devkota and Pyakurel, 2017).

The males dominating the seed selection in male-headed households was 6.08 times higher than female-headed households (P<0.001). Males were 39% more likely to influence the seed selection in elite groups as compared to marginalized groups (P<0.001). In the households with agriculture as primary occupation, 56% higher male domination was found in the selection of seeds (P<0.001). The relation was non-significant with education and area of cultivation. The model was found to be significant ($X^2=322.57$, P<0.001). 15% variation in the dependent variable (seed selection with respect to gender) was explained as independent variables. The result was 72% predicted correctly (Table 4). As a selection of seed is a decision-making process it is also dominated by males in male-headed, elite, and agricultural families (Bhattarai, Beilin and Ford, 2015). Nepal being an agrarian society, the influence of females in family decisions is negligible (Upreti *et al.*, 2018).

The domination of females in male-headed households for seed sowing was 4.18 times more as compared to female-headed households (P<0.001). In the family with agriculture as a primary occupation, 59% of higher male domination was found for a similar purpose as compared to other occupational families (P<0.001). Similarly, for the same purpose, the male domination was 37% more in the educated families as compared to uneducated (P<0.01). The relation was not significant with occupation and area of cultivation. The model was found to be significant ($X^2=221.82$, P<0.001). 10.3% variation in the dependent variable (seed sowing with respect to gender) was explained by independent variables. The result was 66.4% predicted correctly (Table 4). Despite

the control of decision-making is in the hands of male, seed sowing is considered as women's task (Halbrendt *et al.*, 2014).

Fertilizer application was found to be dependent on the type of household, ethnicity, and occupation of the respondents. The odds of fertilizer application were 5.13 times more with respondents whose household was male headed ($P<0.001$). Likewise, males belonging to elite groups were 32% more likely to do fertilizer application ($P<0.01$). Moreover, the fertilizer application was 51% more likely in respondents having agriculture as their occupation ($P<0.001$). 13% variation in the dependent variable (fertilizer application with respect to gender) was explained by independent variables. The relation was found to be not significant with education and area of cultivation. The model was found to be significant ($X^2=260.55$, $P<0.001$). 75.5% of the cases were correctly predicted (Table 5).

In a similar study, Pyakuryal (2017) found that there is a common belief among the people that educated persons should try to keep away from agricultural work as it is related to drudgery and does not provide a fancy and luxurious way of living. Due to this belief, many educated males tend to stay away from agricultural works and females have to take part in field works on their behalf. Purchased inputs such as fertilizers and improved seeds, as well as mechanical tools and equipment, are considerably less likely to be used by women. Women are barely half as likely as males to use fertilizers in many countries (UNDP, 2012). This may be because of a lack of access to resources and knowledge on the use of fertilizers. In the findings of this research, male-dominated households are more likely to use fertilizers in their fields than the female-headed households.

Table 5: Gender differentiation of applying fertilizer, weeding, irrigation, and pest control

	<i>Applying fertilizer</i>	<i>Weeding</i>	<i>Irrigation</i>	<i>Pest control</i>
Type of household (male headed=1)	5.13***	2.94***	7.79***	6.73***
Ethnicity (elite=1)	1.32**	1.33ns	1.20ns	1.02ns
Occupation (Ag=1)	1.51***	1.44***	1.95***	1.75***
Education (educated =1)	1.22ns	-1.42**	1.21ns	1.28ns
Area of cultivated land (ha)	1.08ns	1.03ns	1.30*	1.10ns
Intercept	0.47***	0.36***	0.53***	0.52***
Model Chi square	260.55***	138.37***	357.62***	322.17***
Nagelkerke R ²	0.130	0.065	0.199	0.168
% correctly predicted	75.5	61.5	83.1	79.4

Note: *** = $P<0.001$, ** = $P<0.01$, * = $P<0.05$, ns = not significant

Weeding was found to be dependent on the type of household, occupation, and education of the respondents. The weeding was done 2.94 times more by the respondents who were male headed ($P<0.001$). Similarly, respondents having agriculture as their occupation were 44% more likely to carry out weeding operation ($P<0.001$). Likewise, for the same purpose, weeding was 42% less likely to be carried out by uneducated respondents ($P<0.01$). 6.5% variation in the dependent variable (weeding with respect to gender) was explained by independent variables. The relation was found to be not significant with ethnicity and area of cultivation. The model was found to be significant ($X^2=138.37$, $P<0.001$). 61.5% of the cases were correctly predicted (Table 5). Clearing

the field after plowing and weeding is considered less important that is usually considered as female's work (Belay, 2016).

Irrigation was found to be dependent on the type of household, occupation, and area of cultivated land of the respondents. The irrigation was 7.79 times more likely with the respondents having male-headed households ($P<0.001$). Likewise, respondents with agriculture as their occupation were 95% more likely to carry out irrigation ($P<0.001$). Moreover, the irrigation was 30% less likely with the respondents having few areas of cultivation ($P<0.05$). 19.9% variation in the dependent variable (irrigation with respect to gender) was explained by independent variables. The relation was found to be non-significant with the ethnicity and education of the respondents. The model was found to be significant ($X^2=357.62$, $P<0.001$). 83.1% of the cases were correctly predicted (Table 5). In Nepal, irrigating field is considered as male's work as it is necessary to make channels to direct the movement of water. As this is the "heavy-work", it is mostly practiced by males (Upreti *et al.*, 2018).

Pest control was found to be significant on the type of household and occupation of the respondents. The pest control was 6.73 times more in the respondents having male-headed households ($P<0.001$). Similarly, people having agriculture as their occupation were 75% more likely to carry out pest control ($P<0.001$). 16.8% variation in the dependent variable (pest control with respect to gender) was explained by independent variables. The relation was found to be not significant with ethnicity, education, and area of cultivated land of the respondents. The model was found to be significant ($X^2=322.17$, $P<0.001$). 79.4% of the cases were correctly predicted (Table 5). Domination of males is higher in pest control and spraying of fertilizer (FAO, 2011; Belay, 2016).

The males dominating the harvesting were 6.19 times greater in male-headed households as compared to female-headed households ($P<0.001$). Males of the respondent families with agriculture as primary occupation were 90% more likely to get engaged in harvesting than other occupation families ($P<0.001$). The relation was not significant with ethnicity, education, and area of cultivation. 15.8% variation in the dependent variable (harvesting with respect to gender) was explained by independent variables. The model was found to be significant ($X^2=275.38$, $P<0.001$). 82.8% of cases were correctly predicted (Table 6). As harvesting is considered one of the most important operations, the involvement of family labor is equally important. However, why making decisions, the dominance of males is seen higher in male-headed families (FAO, 2005).

Table 6: Gender differentiation of harvesting, sales of products, and control of income

	<i>Harvesting</i>	<i>Sale of products</i>	<i>Control of income</i>
Type of household (male headed=1)	6.19***	6.88***	15.81***
Ethnicity (elite=1)	1.10ns	1.24*	0.919ns
Occupation (Ag=1)	1.90***	1.29**	1.12ns
Education (educated =1)	1.25ns	1.56***	1.09ns
Area of cultivated land (ha)	1.11ns	1.14ns	1.00ns
Intercept	0.73*	0.39***	0.68**
Model Chi square	275.38***	322.92***	532.02***
Nagelkerke R ²	0.158	0.159	0.297
% correctly predicted	82.8	76.5	86.6

Note: *** = $P<0.001$, ** = $P<0.01$, * = $P<0.05$, ns = not significant

Sales of products were 6.88 times more likely dominated by males in male-headed households as compared to female-headed households ($P<0.001$). The males dominating

the sales of products were 24% less likely in marginalized groups as compared to elite groups ($P<0.05$). The males of the respondent family with agriculture as primary occupation were 29% more likely to have sales of products than the families with other occupations ($P<0.01$). Also, the male domination in sales of products was 56% more with educated respondents than the uneducated ones ($P<0.001$). The relation was not significant with the area of cultivation. 15.9% variation in the dependent variable (sale of products with respect to gender) was explained by independent variables. The model was found to be significant ($X^2=322.92$, $P<0.001$). 76.5% of cases were correctly predicted (Table 6). The sales and marketing of the product are considered to be male's work (Bhattarai *et al.*, 2015).

Similarly, the domination of males in controlling the income was 15.81 times more likely in male-headed households as compared to female-headed households ($P<0.001$). The relation was not significant with ethnicity, occupation, education, and area of cultivation. 29.7% variation in the dependent variable (control of income with respect to gender) was explained by independent variables. The model was found to be significant ($X^2=532.02$, $P<0.001$). 86.6 % of cases were correctly predicted (Table 6). The control of household income is dominated by males in male-headed households. However, as females are responsible for household management, the income can be equally governed by women (Bhattarai *et al.*, 2015).

The values signify that the male members of the family are more responsible for the decision-making process and carry out the “heavy and more important tasks”. On the contrary, women are responsible for light works like weeding and irrigation considered “less-important works” (Belay, 2016). Previous studies by Poudel *et al.* (2009) and UNDP (2012) have disclosed that, irrespective of areas, women are more involved in crop production, processing, and post-harvesting activities than men. While men generally perform tasks that require heavy physical labor such as plowing, women are more commonly involved in tasks such as weeding, harvesting, threshing, and milling (FAO, 2005; Halbrendt *et al.*, 2014). In general, both men and women farmers are busy during the labor-intensive agricultural season, especially during planting and harvesting times (Halbrendt *et al.*, 2014). Women are found mostly responsible for food preservation and processing; men are generally accountable for crop selling in the markets. Women were mainly involved in the cleaning of storerooms and storing agro-products in bags (to preserve food crops properly for longer periods), preparation, and sale of staple crops. This indicates that women are key contributors to family food and economic security and control of income nowadays. However, due to the out-migration of males of the family, women's workloads increase but they do not experience an increase in decision-making process due to unchanging patriarchal societal structures and gender inequalities (Spangler and Christie, 2019).

3.5 Agrobiodiversity Management Activities Done

The intercropping was 69% more likely to be practiced by respondents with access to extension facilities ($P<0.01$). 2.0% variation in the dependent variable was explained by independent variables. Agrobiodiversity management activity like intercropping was found to be independent of the type of household, ethnicity, occupation, and agricultural training practices. The model was found to be significant ($X^2=42.70$, $P<0.001$). 55.5% of cases were correctly predicted (Table 7). The result showed that the distribution of work between both male and female were some-how equal which is in line with the findings of Halbrendt *et al.* (2014). The respondents with good extension facilities mostly focused on market-oriented cash crops thus resulting in more monocropping than intercropping. In contrast to our result, Ketema and Bauer (2012) stated that as access to extension service increased, the probability to practice intercropping also increased by

11.9%, implying that the technical information provided to farmers through extension agents incorporate intercropping techniques among others.

Table 7: Factors affecting the practices of intercropping, mixed cropping, and crop rotation

	<i>Intercropping</i>	<i>Mixed cropping</i>	<i>Crop rotation</i>
Type of HH (male headed=1)	1.03ns	1.055ns	1.09ns
Ethnicity (elite=1)	0.96ns	0.903ns	1.43***
Education (educated=1)	0.94ns	1.202ns	1.39**
Occupation (non ag=1)	0.95ns	0.96ns	1.10ns
Extension facility (yes=1)	0.69**	0.75**	0.94ns
Training on ag(yes=1)	0.97ns	0.46***	0.51***
Intercept	1.26*	0.75*	0.228***
Model chi square	42.70***	108.28***	80.58***
Nagelkerke R ²	0.020	0.052	0.043
% correctly predicted	55.5	63	77.3

Note: *** = P<0.001, ** = P<0.01, * = P<0.05, ns = not significant

Similarly, mixed cropping practice was also found dependent only on agricultural extension facilities and training. Mixed cropping practice was 75% more likely to be performed by respondents with extension facilities (P<0.01). The relation was non-significant for types of households, ethnicity, education status, primary occupation, and training. 5.2% variation in the dependent variable was explained by independent variables. The model was found to be significant (X²=108.28, P<0.001). 63% of cases were correctly predicted (Table 7). In this case, respondents were trained with modern agriculture techniques which prioritized monocropping of market-oriented high-value crops rather than mixed cropping (Gharti and Hall, 2020).

Crop rotation practice was dependent on ethnicity, training, and education of respondents. Crop rotation was performed 1.39 times more by educated respondents (P<0.01). Also, elite respondents performed crop rotation 1.43 times more than the marginalized ones (P<0.001). In a similar case, 51% of trained respondents were less likely to practice crop rotation than untrained respondents (P<0.001). 4.3% variation in the dependent variable was explained by independent variables. The model was found to be significant (X²=80.58, P<0.001). 77.3% of cases were correctly predicted (Table 7). In recent years, as commercialization in agriculture is increasing at a slow pace, educated farmers are more concerned with proper land utilization resulting in more benefit from a small piece of land resulting in constant practicing of crop rotation (Pandey, 2015).

These techniques of crop diversification are mostly affected by ethnicity, education status of respondents, and the interaction between wealth strata and the size of landholdings (Pandey, 2015). Practices of crop diversification are mostly carried out by resource-poor households with fewer landholdings. Due to modernization in agriculture, most educated persons are more concerned with high value cropping thus, resulting in less practice of mixed cropping. Most of the farmers practiced mixed farming from rural areas where the dominance of subsistence farming prevailed (Iyiola-Tunji *et al.*, 2015). In practice, the crop sequence often changes over time as an adaptation to prevailing conditions, preferences, and knowledge and the different trade-offs that farmers have to consider when choosing a crop (Chongtham *et al.*, 2017).

Table 8: Factors affecting the practices of agroforestry, tree crop animal integration, and occurrence of climate change

	<i>Agroforestry</i>	<i>Tree-crop-animal integration</i>	<i>Occurrence of climate change</i>
Type of HH (male headed=1)	1.00ns	1.10ns	0.955ns
Ethnicity (elite=1)	1.28**	1.14ns	1.625***
Education (educated=1)	1.17ns	1.35**	1.629***
Occupation (non ag=1)	0.92ns	0.79**	1.211*
Extension facility (yes=1)	0.81*	0.86ns	0.67**
Training on ag(yes=1)	0.99ns	0.98ns	0.76*
Intercept	1.99ns	0.94ns	0.31***
Model chi square	29.97***	52.13***	132.85***
Nagelkerke R ²	0.014	0.025	0.066
% correctly predicted	56.3	57.6	71.4

Note: *** = P<0.001, ** = P<0.01, * = P<0.05, ns = not significant

Agroforestry practice was found to be dependent on ethnic groups and extension facilities. Agroforestry was practiced by elite respondents 1.28 times more than the marginalized ones (P<0.01). Agroforestry practice was 81% more prevalent in respondents with extension facilities (P<0.05). The relation was not significant with the type of household, education, and primary occupation of respondents. 1.4% variation in the dependent variable was explained by independent variables. The model was found to be significant ($X^2=29.97$, P<0.001). 56.3% of cases were correctly predicted (Table 8). The result obtained was consistent with the finding of Neupane *et al.* (2002). Elite ethnic groups were likely to practice the agroforestry system as they had good extension facilities, proper technical know-how, and have larger landholdings. However, women dominant ethnic minorities had more constraints in adopting agroforestry compared to men due to the lack of land and labor, lack of knowledge, low educational level, and poor access to extension constrained adoption (Catacutan and Naz, 2015). In a recent study conducted by Dhakal and Rai (2020), the adoption of agroforestry practices showed a positive impact on the provision of extension services. Thus, extension workers provide information to the farmers and help to clarify their doubts (Dhakal and Rai, 2020). On the contrary, even though farmers had frequent contacts with extension workers they may not have received the necessary information and support for agroforestry as most government extension workers are not knowledgeable in agroforestry and hence not able to deliver the technology and practices suitable for farmers (Neupane *et al.*, 2002).

The practice of tree-crop-animal integration was found to be dependent on the education and occupation of respondents. Educated respondents practiced tree-crop-animal integration 1.28 times more than the uneducated ones (P<0.01). Tree-crop-animal integration practice was 79% more prevalent in respondents involved in agriculture (P<0.01). The relation was not significant with the type of household, ethnicity, extension facility, and agricultural training of respondents. 2.5% variation in the dependent variable was explained by independent variables. The model was found to be significant ($X^2=52.13$, P<0.001). 57.6% of cases were correctly predicted (Table 8). Gender analysis in the involvement of tree-crop-livestock integration showed that both participate equally in every activity. Although women's decisions were comparatively

less, there is a somewhat equal division of work between males and females. Educated farmers have evolved and sustained diverse farming systems with the integration of crops, animals, and trees (Pandit, Gautam and Adhikari, 2008). They are capable of accepting tree-crop-livestock integration since they were practicing mixed cropping where they feed their livestock with the product or byproducts of crop and use the animal manure in the farm (Iyiola-Tunji *et al.*, 2015). Farmers need to have sufficient access to knowledge, required assets, and inputs to manage a tree-crop-livestock integration system for economic and environmental sustainability over the long term. Integration of the tree-crop-livestock components minimizes the use of agrochemicals, reduces the opening of new areas for crop or livestock production, and reduces environmental impacts, increasing biodiversity, reducing soil erosion, and improving soil structure and fertility, particularly in combination with conservation agriculture practices such as zero-tillage (Landers, 2007). The tree-crop-livestock system combines cropping, livestock, and forestry activities through approaches such as crop rotation, succession, double cropping, and intercropping, searching for synergistic effects among the components of the agroecosystems (Pacheco, Chaves and Nicoli, 2012).

The knowledge about the occurrence of climate change was found to be dependent on ethnicity, education, primary occupation, extension facility, and agricultural training of respondents. Elite groups had 1.625 times more knowledge of climate change than the marginalized groups ($P < 0.001$). Similarly, educated respondents had 1.629 times more knowledge on climate change than the uneducated ones ($P < 0.001$). The knowledge about climate change was 1.21 times more in the respondent not involved in agriculture ($P < 0.05$). The knowledge about climate change was 67% more in the respondent with extension facilities. Likewise, 76% of respondents with agricultural training had more knowledge of climate change ($P < 0.05$). The relation was not significant with the type of household. 6.6% variation in the dependent variable was explained by independent variables. The model was found to be significant ($X^2 = 132.85$, $P < 0.001$). 71.4% of cases were correctly predicted (Table 8). Farmers who were directly associated with farming activities had a great deal of information about climate change. Those people who were not involved in agricultural activities had no experience, and illiterate or with low education levels were unaware of the occurrence of climate change. According to a recent study by Paudel *et al.* (2020) educated farmers scientifically viewed climate change while others have a religious perspective.

Elite groups were able to know about the occurrence of climate change through different media as they were the resource-rich and educated respondents. Agricultural extension increased awareness of the best available local adaptations that can be used to manage climate risks, whilst at the same time assisting farmers to avoid mal-adaptation by providing and disseminating information to farmers, providing institutional support, and helping meet their needs (Antwi-Agyei and Stringer, 2021; Paudel *et al.*, 2020).

Indigenous communities, especially those in remote rural areas of Nepal, used indigenous knowledge to adapt to both climatic and non-climatic changes for centuries. Indigenous knowledge enabled people to develop effective responses to climate change (NCVST, 2009). The adaptation activities were predominantly driven by their skills, ethnicity, local knowledge, and judgment, which varied according to their agroecological region, vulnerability, available technology and resources, and institutional support. Mostly, farmers practiced crop rotation, crop diversification, intercropping, change in crop varieties, and adoption of climate-resistant crops/varieties to respond to certain climate uncertainties which help in the conservation of agrobiodiversity (Karki, Burton and Mackey, 2020). Farmers in the hills developed different agroforestry models to overcome frequent drought, landslides, and high rates

of soil erosion. Similarly, farmers in the Terai adapted to recurrent floods by constructing bamboo houses that are time and cost-effective (MoSTE, 2015).

3.6 Pesticides Use and Awareness among the Farmers

The use of chemical pesticides was found to be dependent on the ethnicity, occupation, and training on agriculture of the respondents. The use of chemical pesticides was 26% less likely in the marginalized groups of respondents ($P<0.01$). Similarly, respondents having agriculture as their occupation are 15% more likely to use chemical pesticides ($P<0.05$). Likewise, the use of chemical pesticides was 41% less likely in respondents who have not received training on agriculture ($P<0.001$). 3.7% variation in the dependent variable was explained by independent variables. The relation was found to be not significant with types of households, education, and extension facility. The model was found to be significant ($X^2=78.89$, $P<0.001$). 60.1% of the cases were correctly predicted (Table 9). This signifies that the elite groups of people and people who had agriculture as their main occupation were making the use of chemical pesticides for pest control than marginalized groups of people and people involving in other occupations. Also, people who got training in agriculture were making the use of chemical pesticides than people who had not received any training related to agriculture by taking suggestions from nearby agrovets (Sapkota et al., 2020). As majority of marginalized groups are involved in subsistence farming and most of the produce is consumed by themselves, they prefer not to use chemical pesticides. Also, due to a lack of technical knowledge in pesticides, the use of chemical pesticides is minimum (Bhatta and Doppler, 2010).

Table 9: Factors affecting the use of chemical pesticides, see pesticide label before application and follow waiting period of pesticides

	<i>Use of chemical pesticides</i>	<i>See pesticide label before application</i>	<i>Follow waiting period of pesticides</i>
Type of HH (male headed=1)	0.93ns	1.3ns	1.21ns
Ethnicity (elite=1)	1.26**	1.69***	1.82***
Education (educated=1)	1.18ns	1.92***	1.48*
Occupation (ag=1)	0.85*	1.04ns	1.49**
Extension facility (yes=1)	0.98ns	0.70ns	0.57**
Training on ag(yes=1)	0.59***	0.57***	1.12ns
Intercept	1.17***	0.69*	0.30ns
Model chi square	78.89***	94.98***	65.66***
Nagelkerke R ²	0.037	0.104	0.074
% correctly predicted	60.1	61.4	63.6

Note: *** = $P<0.001$, ** = $P<0.01$, * = $P<0.05$, ns = not significant

Seeing pesticide labels before pesticide application was found to be dependent upon ethnicity, education, and training on agriculture of the respondents. Reading the label before pesticide application was 69% more likely practiced in elite groups of respondents ($P<0.001$). Moreover, respondents who were educated were 92% more likely to read the pesticide label before pesticide application ($P<0.001$). Similarly,

respondents who have not received training on agriculture are 43% less likely to read the label before pesticide application ($P < 0.001$). 10.4% variation in the dependent variable was explained by independent variables. The relation was found to be not significant with types of households, occupation, and extension facility. The model was found to be significant ($X^2 = 94.98$, $P < 0.001$). 61.4% of the cases were correctly predicted (Table 9). This signifies that the elite groups of people were seeing the pesticide label before pesticide application. The respondents who were educated were also reading the label of pesticide before application. The uneducated ones were not following the instructions in the pesticide container due to their inability to read the international language (Sapkota *et al.*, 2020). Also, the group of people who had not received training on agriculture and the uneducated group were not seeing the label of pesticides before the application due to lack of technical knowledge and inability to read instructions in international language (Kafle *et al.*, 2021).

The duration from application of pesticides to the harvest of crop in the field is called as waiting period. In order to reduce the health hazard, it is utmost necessary to follow the waiting period as it provides sufficient time to nullify the residual effect of chemical. Ethnicity, education, occupation and extension facilities significantly affected the following of waiting period after application of pesticides. Elite groups were 82% more likely ($P < 0.001$), educated farmers were 48% more likely ($P < 0.05$) and farmers with agriculture as primary occupation were 49% more likely to follow the waiting period in comparison to their counterparts. Moreover, for the same purpose, respondents with extension facilities are 43% more likely to follow the waiting period ($p < 0.01$). 7.4% variation in the dependent variables was explained by independent variables. The relation was found to be not significant with types of households and training on agriculture. The model was found to be significant ($X^2 = 65.66$, $P < 0.001$). 63.6% of the cases were correctly predicted (Table 9). The value represents that the elites follow the waiting period of pesticide after its application. Also, the educated and the ones with access to extension facilities followed the waiting period for pesticides (Kafle *et al.*, 2021). Thapa *et al.* (2021) found that the majority of farmers do not follow waiting periods of pesticides and do not use make use of pesticides at a safe level. The main reason for not following the waiting period is due to a lack of knowledge of the health hazards caused by chemical pesticides and made those people more prone to pesticide poisoning (Sapkota *et al.*, 2020).

According to Atreya (2007), the usage of pesticides in the home was largely decided by men. Gender differences were also observed in the consideration of wind direction during spraying, prior knowledge of safety precautions, reading and understanding of pesticide labels, and pesticide label awareness. Also, females have more active participation in agricultural works but males receive most of the training related to agriculture that may be the reason for the lack of proper management while doing agricultural works (Joshi and Kalauni, 2019). In Nepal, the consumption of the pesticide is increasing for the agricultural purposes. Therefore, farmers need to be reminded that pesticides are not the only control measures for pest problems and they should be taught to use pesticides in a safe way (Ghimire *et al.*, 2018).

4. Conclusion

The decision-making of the household is highly influenced by the patriarchal traditions even though most of the household and agricultural activities are performed by the women. During this study, biasness was found in obtaining services like training and extension in which elites, males, educated, and resource-rich households were more favored as they were social influencers. Elite groups and educated people had major

knowledge and practices regarding agrobiodiversity and other agricultural practices. The role of women and marginalized people in agrobiodiversity management is more than that of males and elites but their role is ignored and mostly denied. So, to move towards inclusion in agriculture there is a urgent need in mainstreaming the roles of females, marginalized groups, and uneducated resource-poor farmers in agriculture and related works through designing and implementing the policies. Attempts are needed to join the dynamic link between social, ecological, and agrobiodiversity management systems to improve resilience against climate change and for the formulation of effective climate change adaptation and mitigation strategies.

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Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	Author 1	Author 2	Author 3	Author 4	Author 5
Conceived and designed the research or analysis	Yes	No	No	No	No
Collected the data	No	Yes	Yes	Yes	Yes
Contributed to data analysis & interpretation	Yes	No	No	No	No
Wrote the article/paper	Yes	Yes	Yes	Yes	Yes
Critical revision of the article/paper	Yes	Yes	No	Yes	No
Editing of the article/paper	Yes	Yes	No	No	No
Supervision	Yes	No	No	No	No
Project Administration	Yes	No	No	No	No
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(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

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